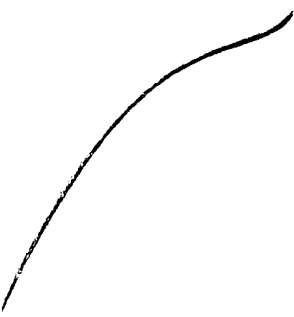


CLEAN VERSION OF CLAIMS

CLAIMS

- 1 1. An apparatus adapted for seismic data acquisition in a land or transition
2 zone environment, said apparatus comprising:
3 a positioning device;
4 a seismic sensor, capable of being placed near said positioning device;
5 and
6 means for determining the distance between said seismic sensor and said
7 positioning device using an airborne acoustic transmission between said
8 positioning device and said seismic sensor.

 - 1 2. An apparatus as claimed in claim 1, in which said airborne acoustic
2 transmission is produced by a speaker at said positioning device and
3 received by a microphone at said seismic sensor.

 - 1 3. An apparatus as claimed in claim 2, in which said airborne acoustic
2 transmission received by said microphone at said seismic sensor is
3 converted from analog to digital format using an analog to digital
4 converter that is also used to convert seismic signals received by said
5 seismic sensor from analog to digital format.
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1 4. An apparatus as claimed in either claim 2 or claim 3, in which said
2 airborne acoustic transmission received by said microphone at said
3 seismic sensor is transmitted using a cable that is also used to transmit
4 seismic data received by said seismic sensor.

1 5. An apparatus as claimed in any one of claims 1 to 4, in which said
2 airborne acoustic transmission is a spread spectrum acoustic signal.

1 6. An apparatus as claimed in any one of claims 1 to 5, in which said
2 airborne acoustic transmission is a pulse, frequency sweep, or digitally
3 encoded sweep acoustic signal.

1 7. An apparatus as claimed in any one of claims 1 to 6, in which said
2 airborne acoustic transmission is generated by signal generation circuitry
3 that is also used to test said seismic sensor.

1 8. An apparatus as claimed in any one of claims 1 to 7, further including a
2 temperature sensor for measuring the temperature of the air near said
3 seismic sensor or said positioning device.

1 9. An apparatus as claimed in any one of claims 1 to 8, further including a
2 survey flag and wherein said positioning device is placed near said
3 survey flag.

1 10. An apparatus as claimed in any one of claims 1 to 9, in which said
2 positioning device is a first positioning device and further including a
3 second positioning device and means for determining the distance
4 between said second positioning device and said seismic sensor using an
5 airborne acoustic transmission between said second positioning device
6 and said seismic sensor.

1 11. An apparatus as claimed in claim 10, further including means for
2 determining the distance between said first positioning device and said
3 second positioning device.

1 12. An apparatus as claimed in claim 11, in which said means for
2 determining the distance between said first positioning device and said
3 second positioning device uses an airborne acoustic transmission
4 between said first positioning device and said second positioning device.

1 13. An apparatus as claimed in any one of claims 10 to 12, in which said first
2 positioning device and said second positioning device are connected by a
3 cable.

1 14. An apparatus as claimed in any one of claims 10 to 13, in which said
2 second positioning device is placed at a predetermined azimuthal
3 orientation with respect to said first positioning device.

1 15. An apparatus as claimed in any one of claims 10 to 14, further including
2 means for confirming that said second positioning device has been placed
3 at a predetermined azimuthal orientation with respect to said first
4 positioning device.

1 16. An apparatus as claimed in any one of claims 10 to 15, in which a
2 seismic source signal is used to determine to resolve the line symmetry
3 ambiguity when determining the position of said seismic sensor with
4 respect to said first positioning device and said second positioning
5 device.

1 17. An apparatus as claimed in claim any one of claims 1 to 16, wherein said
2 seismic sensor is a first seismic sensor and further including additional
3 seismic sensors and means for determining the distance between said
4 additional seismic sensors and said positioning device using airborne
5 acoustic transmission between said positioning device and said additional
6 seismic sensors.

1 18. An apparatus as claimed in claim 17, further including means for
2 calculating a group center of gravity for said first seismic sensor and said
3 additional seismic sensors.

1 19. An apparatus as claimed in claim 17, further including means for
2 determining whether said first seismic sensor and said additional seismic
3 sensors have been laid out in a prescribed order.

1 20. An apparatus as claimed in any one of claims 1 to 19, in which said
2 seismic sensor and said positioning device are located at a first seismic
3 station and further including an additional positioning device located at a
4 second seismic station and means for determining the distance between a
5 device located at said first seismic station and a device located at said
6 second seismic station.

1 21. A method of determining the position of a seismic sensor adapted for
2 seismic data acquisition in a land or transition zone environment, said
3 method comprising the steps of:
4 placing a positioning device in a particular location;
5 placing a seismic sensor near said positioning device; and
6 determining the distance between said seismic sensor and said
7 positioning device using an airborne acoustic transmission between said
8 positioning device and said seismic sensor.

1 22. A method as claimed in claim 21, in which said airborne acoustic
2 transmission is produced by a speaker at said positioning device and
3 received by a microphone at said seismic sensor.

1 23. A method as claimed in claim 22, in which said airborne acoustic
2 transmission received by said microphone at said seismic sensor is
3 converted from analog to digital format using an analog to digital
4 converter that is also used to convert seismic signals received by said
5 seismic sensor from analog to digital format.

1 24. A method as claimed in either claim 22 or claim 23, in which said
2 airborne acoustic transmission received by said microphone at said
3 seismic sensor is transmitted using a cable that is also used to transmit
4 seismic data received by said seismic sensor.

1 25. A method as claimed in any one of claims 21 to 24, in which said
2 airborne acoustic transmission is a spread spectrum acoustic signal.

1 26. A method as claimed in any one of claims 21 to 25, in which said
2 airborne acoustic transmission is a pulse, frequency sweep, or digitally
3 encoded sweep acoustic signal.

1 27. A method as claimed in any one of claims 21 to 26, in which said
2 airborne acoustic transmission is generated by signal generation circuitry
3 that is also used to test said seismic sensor.

1 28. A method as claimed in any one of claims 21 to 27, further including the
2 step of measuring the temperature of the air near said seismic sensor or
3 said positioning device.

1 29. A method as claimed in any one of claims 21 to 28, in which said
2 positioning device is placed near a survey flag.

1 30. A method as claimed in any one of claims 21 to 29, in which said
2 positioning device is a first positioning device and further including the
3 step of determining the distance between a second positioning device and
4 said seismic sensor using an airborne acoustic transmission between said
5 second positioning device and said seismic sensor.

1 31. A method as claimed in claim 30, further including the step of
2 determining the distance between said first positioning device and said
3 second positioning device.

1 32. A method as claimed in claim 31, in which said step of determining the
2 distance between said first positioning device and said second
3 positioning device uses an airborne acoustic transmission between said
4 first positioning device and said second positioning device.

1 33. A method as claimed in any one of claims 30 to 32, in which said first
2 positioning device and said second positioning device are connected by a
3 cable.

1 34. A method as claimed in any one of claims 30 to 33, in which said second
2 positioning device is placed at a predetermined azimuthal orientation
3 with respect to said first positioning device.

1 35. A method as claimed in any one of claims 30 to 34, further including the
2 step of confirming that said second positioning device has been placed at
3 a predetermined azimuthal orientation with respect to said first
4 positioning device.

1 36. A method as claimed in any one of claims 30 to 35, in which a seismic
2 source signal is used to determine to resolve the line symmetry ambiguity
3 when determining the position of said seismic sensor with respect to said
4 first positioning device and said second positioning device.

1 37. A method as claimed in any one of claims 21 to 35, wherein said seismic
2 sensor is a first seismic sensor and further including additional seismic
3 sensors and the step of determining the distance between said additional
4 seismic sensors and said positioning device using airborne acoustic

5 transmissions between said positioning device and said additional
6 seismic sensors.

1 38. A method as claimed in claim 37, further including the step of calculating
2 a group center of gravity for said first seismic sensor and said additional
3 seismic sensors.

1 39. A method as claimed in claim 37, further including the step of
2 determining whether said first seismic sensor and said additional seismic
3 sensors have been laid out in a prescribed order.

1 40. A method as claimed in any one of claims 21 to 39, in which said seismic
2 sensor and said positioning device are located at a first seismic station
3 and further including an additional positioning device located at a second
4 seismic station and the step of determining the distance between a device
5 located at said first seismic station and a device located at said second
6 seismic station.

1 41. A method as claimed in any one of claims 21 to 40, further including the
2 steps of recording seismic data acquired by said seismic sensor and
3 assigning sensor position coordinates to said seismic data based on said
4 distance between said seismic sensor and said positioning device.

1 42. A method as claimed in any one of claims 21 to 41, further including the
2 step of calculating a deviation between actual seismic sensor position
3 coordinates and planned seismic sensor position coordinates.

1 43. A method as claimed in claim 42, further including the step of
2 compensating for said deviation between said actual seismic sensor
3 position coordinates and said planned seismic sensor position
4 coordinates.

1 44. A method as claimed in claim 43, in which said compensation step
2 includes mathematically moving a group center of gravity from an actual
3 position to a planned position.

1 45. A method as claimed in claim 44, in which said compensation step
2 includes bypassing a digital ground roll removal process.